Tile Drainage - Questions and Answers

Answers to Frequently Asked Questions about Tile Drainage and the Environment

Topics:
1. Tile Drainage and Water Quality
2. Tile drainage and dry weather
3. Tile drains and runoff, flooding

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1. Tile Drainage and Water Quality

Can tile drainage water become contaminated?

Yes. Various studies have reported elevated levels of nitrogen [1,2], pesticides [3,4] and pathogens [5,6] in tile drainage outflow from chemical additives and manure. Nitrogen in its nitrate form (NO_3-N) dissolves readily in water. This means it can move relatively easily through the soil profile in the "soil water", and may be intercepted by tile drains. Some pesticides are soluble and can move through the soil in a similar fashion. Surface cracks, worm burrows or root channels, also called Amacropores@, can sometimes directly connect the tile drains to the surface, increasing the potential for tile water contamination [7].

Does that mean that tile drainage is bad for the environment?

No. Though it is true that tile outflow can become contaminated with some pollutants, that does *not* mean that tile drainage systems should be eliminated because of environmental concern. Under proper management, tile drainage is an important part of environmental farm management. Due to both decreased surface runoff and increased infiltration[8,9], tile drainage can reduce soil erosion, phosphorus (P), potassium (K) and pesticide losses from fields by as much as 40, 48, 29, and 35% respectively [10,1,11]. The soil filters out potential contaminants as the water percolates through it, storing them until they are taken-up by plant roots or biodegraded by soil organisms. Tile drainage is a Best Management Practice (BMP) for erosion and surface water quality control [1,8,12].

What can be done to minimize contamination in tile drainage?

It is possible to minimize the contamination of tile drains by managing nutrients and chemicals in an environmentally responsible manner. The risk of contaminating tile water is greatest with heavy tile water flow. An environmental land manager should only apply the recommended amount of nutrients or chemicals and should avoid applying too soon before or after a rainfall event [13]. Surface tillage prior to application of nutrients/chemicals can reduce the risk of contamination through macropores [6]. Proper care should be taken when installing tile drains near a manure storage area to ensure that no links between the storage and the subsurface tiles exist.

Technologies which promote reactions either within the soil, or end-of-pipe are currently being developed to reduce NO_3-N, P, K and pesticide concentrations in tile effluent. These technologies include: controlled drainage/sub-irrigation, constructed wetlands, and bioreactors in tile outlets [14,15,16]. They require a higher level of management and can be more costly to operate.

How can tile water quality be monitored?

Simply stated: through testing. Discolouration, odour, or excessive foaminess can be indicators of potential tile drain contamination. Lab testing of a sample may be needed to confirm suspected contamination. Some labs only test water samples, while others are more diverse in their services. The Canadian Association for Environmental Analytical Laboratories (CAEAL) offers a directory of accredited labs on their website: www.caeal.ca. Other labs may exist in your area, and a phone call will help establish services and prices. Nitrogen as NO_3-N, as well as P, K, bacteria and fecal coliform (if manure is being spread) are good water quality indicators to have tested.

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2. Tile drainage and dry weather

Is it possible to over-drain land?

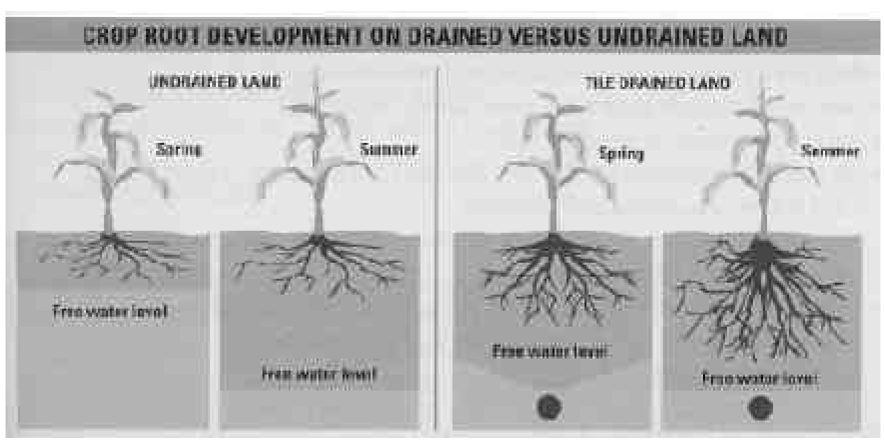
No. The purpose of tile drainage is to remove *excess* water from the upper layer of the soil faster than evaporation alone would remove the water. Excess water, sometimes referred to as “loose water”, moves freely towards the tile drain through large pores in the soil. The forces of adhesion and surface tension hold the water needed for plant uptake in a network of tiny micropores in the soil, called capillaries[1]. These forces prevent capillary water from running into tile drains. Thus, tile drainage does not Adry-up@ the soil, and it does not take away water which can be used by plants.

How do tile drains act in dry periods?

For the most part, tile drains are not active during dry periods. When the soil is dry, it acts like a sponge, holding added water in the many micropores. The soil will do this whether it is tile drained or not. However, some soils with tile drainage will actually have a *higher* capacity to adsorb water during dry times because they are more porous, which is to say there are more micropores, compared to soil which is untiled [2].

If there is a long period of time without rain, cracks may form in the soil, sometimes extending metres deep, in tiled and untiled soils alike. Tiles are generally laid at 12-15m intervals, so a large proportion of rain that falls into cracks will not be intercepted, or carried away, by tile pipes. Further, during a dry period, the watertable is likely below the tile line. If water does get into the tile drain, it will just run out the holes in the bottom of the tile-pipe and continue to percolate through the soil.

How does tile drainage affect crops during drier conditions?



During drier periods, tile drainage does little to affect crop production, per se. However, crops grown in tile drained soil are likely more tolerant to dry conditions. In the spring, when plants are forming their root systems, tile drainage removes water from the root zone more rapidly than where there is no tile drainage. As a result, plants develop roots which extend deeper into the soil (see diagram). During drier conditions, plants with deeper and more extensive roots are able to forage for water (and nutrients) more effectively. This is likely to result in improved crop productivity and yields [3].

References

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3. Tile drains and runoff, flooding

How can tile drained fields have more water storage capacity than undrained fields?

Many studies have reported that tile drained fields have more water storage capacity than their undrained equivalents [1,2,3,4,5,6,7,8]. To understand why this is the case, think about a bucket filled with sponge. Initially, the sponge will absorb most added water. When the sponge becomes saturated, excess water will start to collect at the bottom and slowly rise to the top of the bucket. Much time must pass before evaporation appreciably lowers the water level to allow more water to be stored in the bucket.

Now consider the effects of drilling a hole in the bucket about halfway up the side. Like before, the water is initially absorbed by the sponge until saturation. After that point, if water rises above the hole, the excess amount will flow out of the bucket until it is level with the hole again. Water is taken out of the second bucket (with the hole) at a much faster rate than from the first bucket which relies on evaporation to lower water levels. After a few minutes, the second bucket will be able to hold more water. In the same amount of time, the bucket with no hole will *not* be able to hold more water.

The same principle applies to undrained and drained fields. A tile drained field is able to remove excess water through the tile drains during wet periods to provide storage volume within the soil profile for the next rainfall[9]. On the other hand, an undrained field must rely on evaporation to remove excess water; this can take *weeks*. With drainage, it might take a few *days* [2,9].

Why would an increased water storage capacity in soils be an advantage?

One advantage of having increased storage capacity in the soil is that runoff volumes and associated soil erosion can be reduced [8]. Nutrients, such as nitrogen (N), phosphorus (P) and potassium (K) [10] and some pesticides [11] are often dissolved in runoff water or attached to suspended sediments. If delivered to surface water, they can contaminate the water they run into. By installing tile drainage, runoff volume, and associated losses can be reduced. Further, as runoff water travels down ditch or river banks, high amounts of erosion can occur. This can diminish surface water quality [12]. Tile drainage has been recommended as a best management practice (BMP) for erosion reduction [5,9] and water quality control [13].

Another advantage that increased storage capacity offers is flood control. Water takes more time to move through the soil and drain out of a tile than to run across the surface and into a channel. Therefore, there is more time between the start of rainfall and peak flow [2,7,12]. Depending on initial conditions, peak flow can be reduced by as much as 87% compared to undrained fields [5].

So tile drainage helps to minimize flooding in an agricultural watershed?

Yes, because of the additional storage capacity it offers. Tile drainage is often unfairly blamed for increased flooding in an area because tile outlets can be seen running. A more likely culprit is land use change. During the 19th and early 20th century, much "natural" land was converted into agricultural land, which can be linked to different flooding patterns. Though natural wetlands and forests offer the best flood control, agricultural production is essential [to the economy and society]. Tile drainage should be viewed as a way to minimize flooding in an *agricultural* watershed. The rate of conversion of natural land to agricultural land has slowed in recent times due to economic forces and policy regulations [1]. Increased productivity resulting from tile drainage [14 15 16], may further discourage conversion of natural land into agricultural land.

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